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Effect of Climate Change on Sustainable Development in Nigeria: Fully Modified Ordinary Least Square Method

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Abstract
The study evaluated the effect of climate change on sustainable development in Nigeria. Specifically, the study sought to: investigate the effect of carbon emission on sustainable development in Nigeria and examine the effect of green-house gas on sustainable development in Nigeria. This study used ex post-facto research design. The method of data analysis used are Augmented Dickey-Fuller Unit Root test statistic, Johansen Co-integration test, fully modified Ordinary least square method and Histogram Normality Test. The empirical result showed that carbon emission has negative and insignificant impact on sustainable development in Nigeria because [t-Statistic; 0.8360; P-value (0.4102) > sig-value (0.05] and green-house emission has positive and significant impact on sustainable development in Nigeria because [t-Statistic; -0.8360; P-value (0.2303) > sig-value (0.05]. This study concludes that climate change has negative and insignificant impact on sustainable development in Nigeria. The study identify that green-house emission (GRHG), carbon emission (CARBON) and Deforestation (FOREST) have negative and insignificant impact on sustainable development in Nigeria. The study recommended that policymakers should focus on increasing the proportion of biomass energy consumption in total energy use to establish a sustainable future. Biomass energy consumption in terms of renewable energy rises environmental quality; hence, with increasing economic development.

Keywords: Climate change; Forest depletion; Sustainable development; Carbon emission Green-house emission

Introduction

Background of the study

Climate change is causing an increase in the global average temperature. Natural phenomena and human activities are believed to be contributing to the increase in the global average temperature. This is mainly due to the increase in greenhouse gases such as carbon dioxide (CO2). Nigeria is experiencing adverse climate conditions with negative impacts on the welfare of millions of people (Olaniyi, Ojekunle & Amujo, 2023) [25]. In a country that relies on rain-fed agriculture, prolonged droughts and floods, unseasonal rains and dry spells have upset the balance of the growing season. Alarm bells are ringing. Lakes in arid and semi-arid regions are drying up and rivers are shrinking, resulting in reduced supplies of water for agriculture, hydroelectric power, and other uses. The main cause of all this disruption is climate change.

Climate change is described as statistical fluctuations that persist for long periods of time, usually more than a decade. These include changes in the frequency and severity of sporadic weather events, and a slow but continuing increase in the Earth's mean surface temperature (Intergovernmental Panel on Climate Change [IPCC, 2001]). The German advisory council on climate change noted that climate change is a threat already having substantial impact on human beings and the natural eco-system both in developed and developing countries but at varying degrees (Ogbuabor & Egwuchukwu, 2017) [23].

In developed countries, the impacts of climate change are perceived to be less severe due to natural advantages, sophisticated adaptation techniques, advanced technology, mechanized agriculture, and wealth conditions. Thanks to these factors, developed economies have been able to mitigate the adverse effects of climate change. For developing countries like Nigeria, the impacts of climate change are crucial, considering the high temperature levels, low adaptability, and lack of early warning systems. Apart from the above, climate change affects economies whose economic activities are dependent on natural resources such as agriculture.

In Nigeria, climate change is also affecting forestry through erosion and strong winds, leading to a decline in forest products such as timber and sugarcane. This will result in fewer forest products and lower incomes, as well as higher material costs for construction and furniture. Nhung and Nguyen, (2018) [20] estimated the cost of deforestation and losses in non-timber forest products in the last 5 years in Nigeria at N120 billion per year, which is equivalent of 1.7% of gross domestic product (GDP) in 2003. Climate change clearly poses a potential threat to the composition of agricultural production in particular, and to the national production in general. The vision of NASPA-CCN is a Nigeria where adaptation to climate change is an integrated part of sustainable development. This will reduce vulnerability of all economic sectors and all people to the adverse impacts of climate change and increase resilience and adaptive capacity while capitalizing on the opportunities presented by climate change. Therefore, this study extends previous studies on Nigeria and focuses on assessing the impact of climate change on sustainable development in Nigeria.

Statement of Problem

Climate change is an undeniable environmental threat of the 21st century that the world is currently experiencing, and measures exist to adapt to and mitigate its effects. Concerns over the adverse effects of climate change have raised fears that environmental degradation and demographic pressures will displace millions of people in Africa and cause serious social unrest Climate change could negatively affect Nigerian economy with various observable impacts ranging from significant reduction in agricultural productivity to increase in illness, morbidity and mortality rate (Mfonobong, Okoye & Nweze, 2020) [18].

Climate change has the potential to affect African agriculture in a range of ways leading to an overall reduction of productivity which could result to a loss in GDP of between 2 % to 7 % in 2100 in the Sahara and 2 to 4% in Western Africa (Osadumem & Edih, 2021) [26]. Over 80% of Nigeria's population relies primarily on rain-fed agriculture and fishing, exposing the country to a high risk of adverse impacts on its food production system due to variations in the timing and amount of rainfall. Climate change will affect the nature and characteristics of freshwater resources on which Nigeria depends. Weather and climate changes are known to have a significant impact on water resources, which in turn contributes to increased susceptibility to infectious diseases in humans. Impacts will vary across ecozones, exacerbating the problem from too much water (flooding) to too little water (drought), resulting in poor water quality, saltwater intrusion, sea-level rise, and reduced water quality in surface areas and groundwater systems.

Climate change impacts human health directly and indirectly in a variety of ways. Changes in temperature and precipitation, sea level rise, and increased frequency will have a significant impact on human health in the areas of injury, disease, morbidity, and mortality. Sea levels are expected to rise as a result of climate change; therefore, flooding may occur, increasing the vulnerability of the poor to malaria, typhoid, cholera, and pneumonia. This entails that variations in water levels in lakes and rivers will greatly cause an adverse effect on inland waterway transportation. It is against this background that the study is carried out.

Objectives of the Study

The broad objective of the study is to evaluate the effect of climate change on sustainable development in Nigeria. The specific objectives are to:

- Investigate the effect of carbon emission on sustainable development in Nigeria.
- Examine the effect of green-house gas on sustainable development in Nigeria.

Research Questions

This study seeks to provide answers to the following research questions.

- To what extent does carbon emission effects sustainable development in Nigeria?
- What is the effect of green-house gas on sustainable development in Nigeria?

Conceptual Literature

Climate Change

Climate change reflects the variations in the average daily weather conditions such as temperature, humidity, rainfall and sunshine of a location over an extended period (Apata, 2022) [7]. Climate change in Nigeria has led to seasons of drought and excess flood, which affected agricultural activities and caused a loss of shelter (Nebedum and Emodi, 2021) [19]. Climate change refers to an increase in average global temperatures. Natural events and human activities are believed to be contributing to an increase in average global temperatures. This is caused primarily by increases in greenhouse gases such as Carbon Dioxide (CO2) (Aigbedo & Aigbovo, 2020) [4].

The main driver of climate change is the human proliferation of the greenhouse effect (Abidoye & Odusola, 2022) [2]. Anthropogenic factors such as household energy consumption, urbanization, deforestation, transportation, agriculture, and burning of fossil fuels for industry increase the concentration of greenhouse gases (GHGs) in the atmosphere, which increases the Earth's temperature and causes associated global warming. Global warming, a clear sign of climate change, is caused by the storage of heat radiated from the Earth to space by greenhouse gases such as chlorofluorocarbons (CFCs), methane (CH4), carbon dioxide (CO2), and nitrous oxide (N2O).

Sustainable Development

Sustainable development is the idea that human society must be able to live and meet its needs without compromising the ability of future generations to meet their own needs. The “official” definition of sustainable development was developed for the first time in the Brundtland Report in 1987. Specifically, sustainable development is a way of organizing society so that it can survive in the long term. It takes into

account both present and future needs, including the protection of the environment and natural resources, and social and economic justice.

Sustainable development can be achieved by following points: It can be achieved by restricting human activities; technological development should be input effective and not input utilizing; the rate of consumption should not surpass the rate of salvation; for renewable resources, the rate of consumption should not surpass the rate of production of renewable substitutes; all types of pollution should be minimized and it can be achieved by sensible use of natural resources (Guntukula & Goyari, 2020) [13]. Sustainable development is an organizing principle that aims to meet human development goals while also enabling natural systems to provide necessary natural resources and ecosystem services to humans (Ikhuoso, 2020) [14]. The desired result is a society where living conditions and resources meet human needs without undermining the planetary integrity and stability of the natural system (Khan, Yu, Sharif & Golpîra, 2020) [16]. Sustainable development tries to find a balance between economic development, environmental protection, and social well-being. The Brundtland Report in 1987 defined sustainable development as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (Liu, Huang & Yang, 2020) [17].

Contextual Literature

Effect of carbon emission on sustainable development.

Climate change is described as a statistical fluctuation that persists for a long period of time, usually more than a decade. It includes shift in the frequency and magnitude of sporadic weather events as well as the slow but continuous rise in global average surface temperature (Intergovernmental Panel on Climate Change [IPCC, 2001]). The German advisory council on climate change noted that climate change is a threat already having substantial impact on human beings and the natural eco-system both in developed and developing countries but at varying degrees (German Advisory Council on Global Change [WBGU, 2003]).

According to research studies, climate change could be the main cause of reduced agricultural yields and increased food risks, worsening disease incidence and the gap between the rich and poor (Olaleye, Ayodele & Ariyo, 2020) [24]. It is becoming increasingly clear that the fundamental issue of climate change needs to be brought much more to the forefront. Climate change is a global issue in the post-industrial era of 'rethinking' the costs of development, although the African continent is barely responsible for its history (Abdulmalik, Attahir& Suleiman, 2020) [1]. If some African countries invest economic resources in climate change mitigation and adaptation, their economic growth will be limited because these resources are also needed to improve infrastructure and increase social prosperity. Akorede and Afroz, (2020) [5] opined that Africa is the region most severely affected by climate change, yet it obviously contributes to a small proportion of global greenhouse emissions.

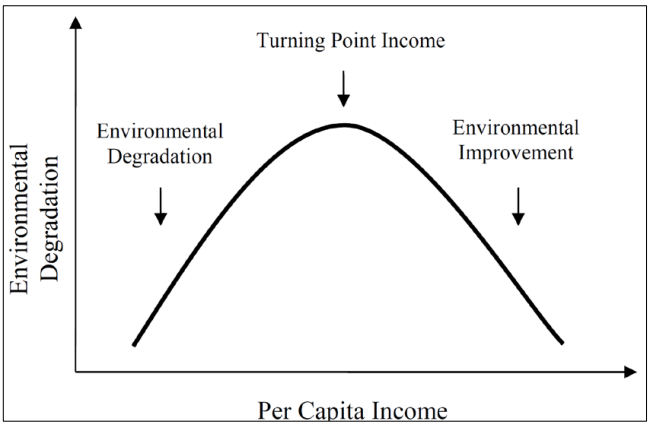
Effect of green-house gas on sustainable development.

Greenhouse gases are classified as both anthropogenic and natural gas components of the atmosphere. These components are known to absorb and emit radiation of specific wavelengths within the infrared spectrum emitted by clouds, the atmosphere, and the Earth's surface. Giedrė, Manuela and Pranas, (2018) [12] asserted that greenhouse gases remain a significant cause of climate change and global warming. This is consistent with Snober, (2020) [29] argument that the adverse effects of climate change due to greenhouse gases on human health, the environment and society are profuse. Hence, Akorede and Afroz (2020) [5] concluded that over 150,000 deaths per year are attributed to the resultant effects of environmental pollution. Although there are many greenhouse gases, CO2 is attracting more recognition due to its persistence in the atmosphere and for its use as a baseline for estimating the global warming potential (GWP) of other greenhouse gases. Olabanji and Adeolu, (2020) added that between 1990 to 2013, the greenhouse gas concentration has increased by 34% with over 80% of this figure being a resultant effect of CO2 emissions. This is in line with Ofoezie, Eludoyin, Udeh, Onanuga, Salami and Adebayo, (2022) assertion that CO2 emissions have increased significantly from 67 million metric tons to 134 million metric tons.

Theoretical Literature

Environmental Kuznet curve theory

The Environmental Kuznets Curve theory was developed based on and named after Kuznets' (1995) hypothesis on income inequality and economic development. The Environmental Kuznets Curve considers the relationship between various indicators reflecting environmental pollution and per capita income. Pollution increases in the early stages of economic growth, but as income levels reach higher levels, economic growth improves the environment. Thus, the Environmental Kuznets Curve hypothesis proposes that the relationship between GDP and pollution looks like an inverted U-shape (Stern, 2003). If the EKC hypothesis is accepted, then either an inverted U-shaped relationship exists or a tipping point is reached. The EKC is accepted when there is a positive relationship between GDP and CO2 in the short run and a negative relationship between CO2 and GDP in the long run.



Source: Yandle, Bhattarai and Vijayaraghavan, (2004)

Fig 1: Environmental Kuznets Curve

The curve is depicted as an inverted U-shaped curve. In other words, the theory assumes that as agriculture becomes more industrialized and mechanized, a country's economy will naturally move towards urban areas. As rural populations move to cities, inequality is expected to decrease. The Environmental Kuznets Curve follows the same idea of a

hypothetical relationship between equality and development. The difference is that it places more emphasis on environmental equality. Before the Environmental Kuznets Curve hypothesis was proposed, it was commonly believed that wealthy economies would damage the environment faster than poorer countries. However, the Environmental Kuznets Curve reanalyzed the relationship between environmental health and the economy. The idea is that as the economy grows, the environment will deteriorate until a point when the country reaches a certain average income. Funds are then reinvested in the environment, and ecosystems will recover. Critics argue that economic growth does not always lead to environmental improvement, and in some cases, the opposite may be true.

The relationship between the environment and economic growth has been hotly debated among economists since the 1990s. The subject of these studies is generally the relationship between income levels and pollution at different levels of economic development. The Kuznets curve environmental hypothesis states that pollution increases in the early stages of economic growth. However, above a certain income level, economic growth allows the environment to recover. This indicates that the relationship between income levels and pollution is inverted U-shaped. This type of relationship is influenced by three factors: scale effect, composition effect, and technology effect. Due to economies of scale, when production increases, more natural resources are consumed and environmental damage increases. In other words, the scale effect shows the positive part of the relationship. As the economic structure changes, the composition effect leads to a shift from manufacturing to services, and the reduction in natural resource use reduces environmental pollution. The technology effect refers to the increase in investment in technology as the national income of countries increases. Research and development increase and environmental pollution decreases with the increasing use of environmentally-friendly technologies (Erataş and Uysal, 2014).

Empirical Literature

Iyabo, Lawal, Olayinka & Akinsola, (2021) [15] explored impact of carbon emissions and economic growth in Nigeria. This study tests the environmental kuznet curve (EKC) hypothesis to find evidence of an inverted-U relationship between carbon emissions and economic growth in Nigeria from 1980-2016. Annual time series data was gotten from world development index (WDI). The methods of data analysis were ADF Fisher Chi-square test, Pedroni's co-integration test, Toda Yamamoto Causality Test and Auto-regressive distributive Lag Model ARDL. There is an inverted U relationship or a turning point is reached when EKC hypothesis is accepted. The ekc is accepted if there is a positive relationship between GDP and CO2 on the short run and a negative relationship between CO2 and GDP on the long run. The findings show that Nigeria has not reached a turning point in its level of carbon emissions as economic growth increases. Nigeria is still at the initial stage of growth where carbon emissions accelerate as growth increases. The study recommended that there is need for policies that will broaden the use of renewable energy such as solar, wind energy as energy sources in meeting the energy needs of the fast growing population in Nigeria. There is need to ensure that imported vehicles into Nigeria must meet emission standards to reduce carbon emissions from road transportation. These policies will be instrumental in creating a turning point in carbon emission growth in Nigeria otherwise higher carbon emissions will pose higher risk of future climate change impact in Nigeria and to the rest of the world.

Osadume and Edih (2021) [26] explored the impact of economic growth on carbon emissions in selected West African countries. The main objective of this study was to ascertain whether economic growth will impact carbon emissions covering the period 1980–2019. The study selected six-sample countries in West Africa and used secondary data obtained through the World Bank Group online database. The data analytical techniques were employing panel econometric methods of statistical analysis. The outcome indicates that the independent variable showed a positively significant impact on the dependent variable for the pooled samples in the short-run, with significant cointegration. The study concluded that economic growth significantly impacts the emissions of carbon, and a 1% rise in economic growth will result to 3.11121% unit rise in carbon emissions. The study suggested that policy implementation should encourage the use of energy efficient facilities by firms and government and the establishment of carbon trading hubs. Failure by governments to heed the recommendations of this research will result to serious climate change issues on economic activities with attendant consequences on human health within the region and globally.

Aigbedo and Aigbovo, (2020) [4] examined the impact of climate change on growth in Nigeria. The specific objectives of the study were to ascertain the impact of temperature (TEMP); carbon emissions (CO2) and energy consumption (ENC) on real gross domestic product per capita (RGDPPC) using data for the period 1981-2021. Changes in temperature and carbon emission were used to capture climate change, while energy consumption was used as a control variable. The study employed the error Correction Model and ordinary least squares (OLS) estimation technique. The results indicate that in the long run, carbon emissions affect growth adversely. In addition, energy consumption impacts positively growth in the short run and long run. These results imply that the Nigerian government should evolve and implement policies to curb carbon emissions. In particular, a National Climate Change Commission is required in Nigeria to deal with all climate change issues. Furthermore, the finding that energy consumption stimulates growth in Nigeria means that policymakers/governments at all levels in Nigeria should evolve and implement policies to encourage these desirable outcomes.

Olaleye, Ayodeleand Ariyo, (2020) [24] examined effect of climate change on social development programmes in Kosofe Local Government Area, Lagos State, Nigeria. The specific objectives of the study were to evaluate the effect of climate change on social development programmes, economic support programmes, and self-help project support. The study adopted a descriptive survey research design while a proportional simple random sample was used to select the 250respondents. A standardized questionnaire was used for data collection with a reliability coefficient of .86. Analysis of data was done using descriptive statistics, and regression analysis fixed at the 0.05 level of significance. The findings of the study revealed a significant influence of climate change effect on social development programmes, economic support programmes, and self-help project support. It is therefore concluded that the challenges of climate have equally paved

ways to various economic and social development programmes in order to alleviate the problem created as a result of climate change. The study recommended that there is the need to prevent the effects of climate change in our community through conscientious efforts and serious adaptation measures.

Babatunde and Ayodele (2019) [8] examined the empirical linkage between economic growth and climate change in Africa. Specifically, the study sought to ascertain the CO2 emissions for meteorological a year (CO2); Forest Depletion (FRD) and Average Total Annual Rainfall (AAR) on economic growth (GDPgrt) using annual data for 34 countries from 1961 to 2009.The method of data analysis was ordinary least squares (OLS) estimation technique. The empirical result showed that there is negative impact of climate change on economic growth. Our results show that a 1°C increase in temperature reduces gross domestic product (GDP) growth by 0.67 percentage point. Evidence from sensitivity analysis shows the two largest economies in the Sub-Saharan Africa (Nigeria and South Africa) play a significant role in ameliorating the negative economic impact of climate change in the region. In addition to impact on Africa, this article provides estimates of the impact of climate change on GDP growth of these 34 countries, which can be valuable in appraising national adaptation plans. We do not find evidence that average long-run temperature changes affect long-run economic growth as measured by 5 year averages. The study recommended that Nigeria should firmly continue with the bargaining and active participation in the climate change agreements at the global scale so as to be compensated for the risk of greenhouse gases emitted from industrialized countries which take historical responsibility for emission.

Snober, (2020) [29] conducted a study to examine relationship between energy consumption, environmental emissions and economic growth for Pakistan. The use of energy plays an imperative role in the expansion of the economy so, this study examined the effect of consumption of energy and environment to economic development which derives the economic development of Pakistan's economy. This study used the famous time series ARDL methodology to empirically determine the impact of energy and environment on Pakistan economic development. The empirical results indicate that in both short and long-run, consumption of energy and GDP level boosts economic development. While on the other hand, FDI and non-renewable-energy (fossil fuel) create hurdles in Pakistan's economic development. Due to these hurdles, increase the demand for renewable energy sources like solar and wind energy and investment in the renewable energy sector. The study suggested that Pakistan government should adopt these renewable energy sources which boost economic development and also mitigate the carbon emission level, which creates the environment clean and healthy.

Akorede & Afroz, (2020) [5] explored the relationship between urbanization, CO2 emissions, economic growth and energy consumption in Nigeria. The main objective is to examine the trend analysis of the relationship between energy consumption, carbon dioxide, CO2 emission and economic growth for the period of 1970-2017. The methods of data analysis were Granger causality and autoregressive distributed lag (ARDL) test approach. The results show that in the short run, energy consumption and the previous lag of economic growth have a positive and significant impact on carbon dioxide emission in Nigeria. Only urban population has a negative but significant impact on CO2 emission in Nigeria. In the long run however, urbanization is still statistically significant but negative while energy consumption and economic growth still has a positive and significant impact on CO2 emission. The major reason is that the bulk of the country's energy consumption is from non-renewable means. Thus, the study recommend appropriate measures and mitigation policies needs to be put in place to reduce the damage on the environment and to prevent further destruction.

Gap in Literature

Ubi-Abai and Enobong (2021) [31] investigated the impact of greenhouse gas emissions, climate change on human development in Africa and failed to incorporate Nigeria among study country. The study conducted by Osadume and Edih (2021) [26] explored the impact of economic growth on carbon emissions in selected West African countries covering the period 1980–2019 and failed to point out sources of climate change such as green-house emission, carbon emission and forest depletion, therefore there is need for further research on the effect of climate change on sustainable development in Nigeria.

There is no clear consensus till date in the literature as to whether Environmental Kuznet Curve (EKC) theory obtainable in developing countries especially in Nigeria, this study will bridge the gap by providing clear explanation as regards to cause-effect relationship between climate change and sustainable development in Nigeria.

Methodology

The research design was ex post-facto method. These variables consist of green-house emission (GRHG), carbon emission (CARBON), foreign direct investment (FDI) and deforestation (FOREST) was sourced from World Bank development indicators; United Nations Framework Convention on Climate Change (UNFCCC). 2022 and Food and Agriculture Organization of the United Nations (FAO). 2022. The econometric software for the study was e-view version 9 because it is user- friendly software. The method of data analysis was divided into three phases namely: pre-estimation, estimation and post-estimation. The pre-estimation statistics includes descriptive statistics, Correlation Matrix of the Variables, Augmented Dickey-Fuller Unit Root test statistic, Johansen Co-integration test. The estimation technique includes fully modified ordinary least square (FMOLS) while post-estimation technique involves Histogram Normality Test.

Model specification for the study

The functional form of the model used in this work is specified in equation 5 as

$$RGDPPC = F(GRHG, CARBON, FOREST, FDI) \quad (5)$$

Where RGDPPC is Real Gross domestic product per capita, GRHG is green-house emission, CARBON is carbon emission, FDI is foreign direct investment and FOREST is Deforestation. Equation (3.5) was therefore re-written in linear form as follows:

$$GDPPC = \beta_0 + \beta_1 GRHG_t + \beta_2 CARBON_t + \beta_3 FOREST_t + \beta_4 FDI + \mu_t \quad (6)$$

Where: β0 = Constant term, β_1 to β_8 = Regression coefficients, μ_t= Error Term and t is the period. To reduce the outliers among the variables, all variables will be expressed in logarithmic form.

$$LogGDPPC = \beta_0 + \beta_1 LogGRHG_t + \beta_2 LogCARBON_t + \beta_3 LogFOREST_t + \beta_4 LogFDI + \mu_t \quad (7)$$

Data presentation and analysis

Table 1: Result of Descriptive Statistics

	RGDPPC	GRHG	CARBON	FDI	FOREST
Mean	286573.0	610613.2	2077660.	85571.86	1319.718
Median	290280.4	36184.12	2619652.	101161.9	1128.600
Maximum	379251.6	4890270.	4890270.	210075.8	2100.800
Minimum	202255.7	22255.02	196788.4	17085.80	852.9000
Std. Dev.	66518.73	1324757.	1295103.	56420.79	405.8973
Skewness	-0.060402	2.138604	0.006902	0.749585	0.591167
Kurtosis	1.326318	6.316230	2.127085	2.807109	1.833471
Jarque-Bera	3.989058	41.49685	1.079742	3.236682	3.908164
Probability	0.136078	0.000000	0.582823	0.198227	0.141695
Sum	9743483.	20760850	70640453	2909443.	44870.40
Sum Sq. Dev.	1.46E+11	5.79E+13	5.54E+13	1.05E+11	5436836.
Observations	34	34	34	34	34

Source: Author's Computation from E-view Application Software

The table shows descriptive statistics of the variables. In the model established in the study, there is one dependent variable and four independent variables. These variables consist of Real Gross domestic product per capita (RGDPPC), green-house emission (GRHG), carbon emission (CARBON), foreign direct investment (FDI) and Deforestation (FOREST) respectively. The mean of Real Gross domestic product per capita (RGDPPC) is 286573.0, the median is 290280.4, maximum is 37925.6, minimum was 202255.7, and sum of the variable is 9743483.0 respectively. The mean of green-house emission (GRHG) is 610613.2, the median is 36184.12, maximum is 4890270, minimum is 22255.02, and sum of the variable is 2076850 respectively. The mean of carbon emission (CARBON) is 2077660, the median is 2619652.4, maximum is 2619652.0, minimum is 196788.4, and sum of the variable is 70640453.22 respectively. The mean of foreign direct investment (FDI) is 85571.86, the median is 101161.9, maximum is 210075.80, minimum is 17085.80 and sum of the variable is 2909443.0 respectively. The mean of deforestation (FOREST) is 1319.718, the median is 1128.600, maximum was 2100.800, minimum is 852.9000 and sum of the variable is 44870.40 respectively.

Correlation matrix of the variables

Table 2: Result of Correlation Matrix

	RGDPPC	GRHG	CARBON	FDI	FOREST
RGDPPC	1	0.447413	0.522207	0.8152641	0.7265342
GRHG	0.447413	1	0.2384558	0.578464	0.161188
CARBON	0.522207	0.238455	1	0.544713	0.321737
FDI	0.8152641	0.5784647	0.544713	1	0.777659
FOREST	0.726534	0.161188	0.321737	0.777659	1

Source: Author's Computation from E-view Application Software

This correlation matrix presents a table showing correlation coefficients between sets of variables. Each random variable (X_i) in the table is correlated with each of the other values in the table (X_j). There is no linear relationship between Real Gross domestic product per capita (RGDPPC) and carbon emission (CARBON), (0.447413). There is no perfect linear relationship between Gross domestic product (MANGDP) and manufacturing sector credits (MANCRE) (0.522207). There is no perfect linear relationship between Real Gross domestic product per capita (RGDPPC) and foreign direct investment (FDI) (0.8152641). There is no perfect linear relationship between Real Gross domestic product per capita (RGDPPC) and Deforestation (FOREST) (0.726534). This test presented clear understanding on the assumption of ordinary least square that there is no perfect or exact linear relationship among explanatory variables. The result of correlation matrix showed that every explanatory variable in the study is linearly independent of each other.

Unit root test using augmented dickey-fuller test

Table 3: Results of Stationarity (unit root) test.

Variables	Variables' Name	ADF- Statistic	5% Critical Value	Remark
RGDPPC	Real GDP per capita	-3.20944	-2.957100	1 (1)
GRHG	Green house emission	-5.81108	-2.957100	1 (1)
CARBON	Carbon emission	-7.08070	-2.957100	1 (1)
FOREST	Deforestation	-5.29321	-2.957100	1 (1)
FDI	Foreign direct investment	-7.800260	-2.957100	1 (1)

Source: Author's computation

In the table 4, the variables that were tested with unit root are shown, the values for Augmented Dickey-Fuller (ADF) statistic is presented, the lag level of each variable is identified. The Mackinnon critical values at 5% level of significant were pointed out. The order of integration of each variable was enumerated, and finally the stationarity position of each variable was also stated. When Augmented Dickey-Fuller statistic is greater than Mackinnon 5 percent critical value in absolute term, it is concluded that the variable is stationary. These variables These variables consist of Real Gross domestic product per capita (RGDPPC), green-house emission (GRHG), carbon emission (CARBON), foreign direct investment (FDI) and Deforestation (FOREST) were stationary at first difference, that is they are I(1) process. Therefore, they contain unit root. The existence of unit root in most variables paves way for further investigation on the nature of the long run relationship among the variables.

Co-integration Test Results

Ho = There is no co-integration (no long run relationship among Variable)

Table 4: Co-integration Test Results

Date: 07/23/24 Time: 15:23
Sample (adjusted): 1992 2023
Included observations: 32 after adjustments
Trend assumption: Linear deterministic trend
Series: RGDPPC GRHG CARBON FDI FOREST
Lags interval (in first differences): 1 to 1
Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.863680	131.7498	69.81889	0.0000
At most 1 *	0.688468	67.98181	47.85613	0.0002
At most 2 *	0.433812	30.66175	29.79707	0.0397
At most 3	0.296594	12.45923	15.49471	0.1362
At most 4	0.036834	1.200960	3.841466	0.2731
Trace test indicates 3 cointegrating eqn(s) at the 0.05 level				

* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Source: E-view Results

The co-integration results in table 5 for the model (RGDPPC, GRHG, CARBON, FDI and FOREST) reveals that both trace test indicates 3 co-integrating equation(s) at the 5 percent level of significance. Thus, there is a long-run relationship among the variables (RGDPPC, GRHG, CARBON, FDI and FOREST). We therefore reject the null hypothesis of no co-integration amongst the variables and accept the alternative hypothesis.

Estimation of Regression Model

Empirical Results of the Fully Modified Ordinary Least Square (FMOLS) Approach

Table 5

Dependent Variable: LOGRGDPPC
Method: Fully Modified Least Squares (FMOLS)
Date: 07/23/24 Time: 15:46
Sample (adjusted): 1991 2023
Included observations: 33 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

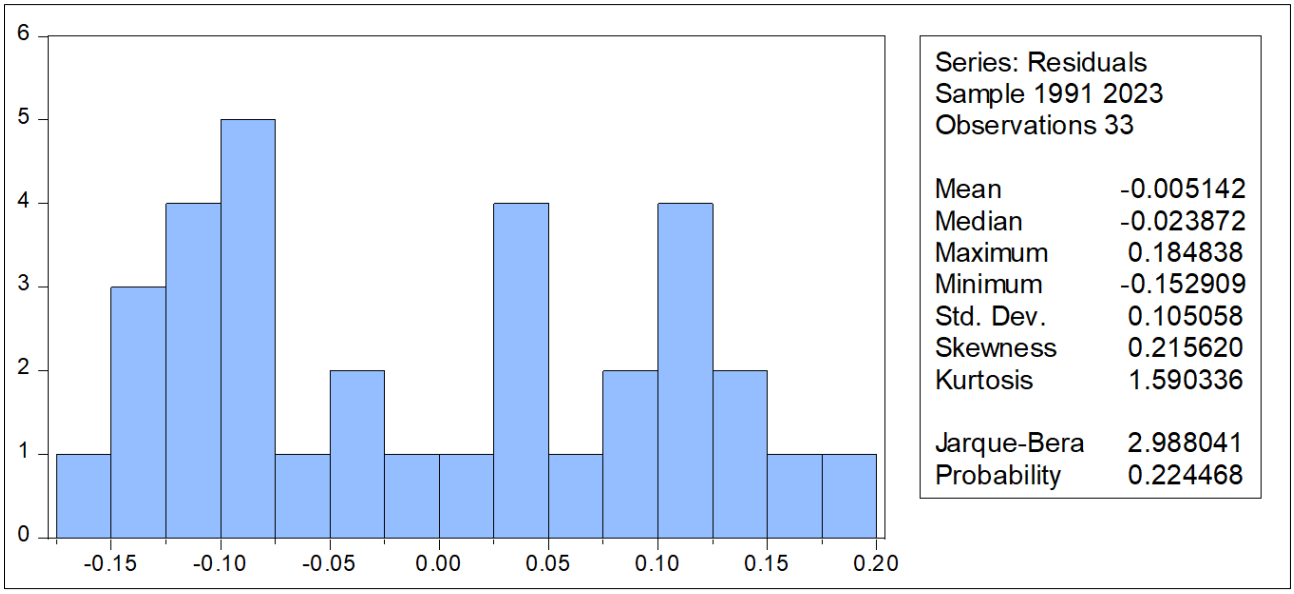
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGGRHG	-0.017412	0.020827	-0.836034	0.4102
LOGCARBON	-0.051162	0.041724	-1.226204	0.2303
LOGFOREST	-0.076013	0.172331	-0.441086	0.6625
LOGFDI	0.406243	0.107096	3.793268	0.0007
C	9.496724	0.751792	12.63212	0.0000
R-squared	0.802618	Mean dependent var		12.54812
Adjusted R-squared	0.774421	S.D. dependent var		0.236761
S.E. of regression	0.112450	Sum squared resid		0.354061
Long-run variance	0.018651			

Source: E-view Results

The Fully Modified Least Squares (FMOLS) model specification was carried out to examine parameters estimates. In testing this hypothesis, green-house emission (GRHG), carbon emission (CARBON), foreign direct investment (FDI) and Deforestation (FOREST) were regressed against Real Gross domestic product per capita (RGDPPC). The result of the regression analysis represents the model for investigating the effect of climate change on sustainable development in Nigeria. The empirical result showed that the coefficient of green-house emission (GRHG)

has negative significant impact on Real Gross domestic product per capita (RGDPPC) because [t-Statistic; -0.8360; P-value (0.4102) > its significant value (0.05]. The empirical result showed that the coefficient of carbon emission (CARBON) has negative and insignificant impact on Real Gross domestic product per capita (RGDPPC) because [t-Statistic; -1.2262; P-value (0.2303) > its significant value (0.05]. The empirical result showed that the coefficient of Deforestation (FOREST) has negative and insignificant impact on Real Gross domestic product per capita (RGDPPC) because [t-Statistic; -0.4410; P-value (0.6625) > its significant value (0.05]. The foreign direct investment (FDI) has positive and significant impact on Real Gross domestic product per capita (RGDPPC) because [t-Statistic; 3.7932; P-value (0.0007) > its significant value (0.05]. Again, our empirical result showed that the R-squared (R^2) is 0.8030.

Econometric /Second Order Test
Histogram Normality Test



Sources: E-view 9.0 Version

Fig 2

The null hypothesis is that there is skewness and Kurtosis in the model. We reject null hypothesis and accept the alternative that there is no skewness and Kurtosis in the model because its P-value of Jarque-Bera (JB) test (2.988) is greater than its 5% significant level (0.05). This implies that the standardized residuals from the estimated model in the regression framework is normally distributed, which is consistent with the OLS assumption.

Test of Hypotheses

The results for the various hypotheses testing are presented in the section.

Test of Hypothesis one

H_{O1} Carbon emission has no significant effect on sustainable development in Nigeria.

In testing this hypothesis, carbon emission (CARBON) was regressed against Real Gross domestic product per capita (RGDPPC). The empirical result showed that the coefficient of carbon emission (CARBON) has negative and insignificant impact on sustainable development in Nigeria because [t-Statistic; 0.8360; P-value (0.4102) was greater than its significant value (0.05]. The null hypothesis was accepted and alternative hypothesis was rejected.

Test of Hypothesis two

H_{O2} Green-house gas has no significant effect on sustainable development in Nigeria.

In testing this hypothesis, green-house emission (GRHG) was regressed against real GDP. The empirical result showed that the coefficient of green-house emission (GRHG) has positive and significant impact on sustainable development in Nigeria because [t-Statistic; -0.8360; P-value (0.2303) was greater than its significant value (0.05]. The null hypothesis was accepted and alternative hypothesis was rejected.

Discussion of the Results

Effect of carbon emission on sustainable development in Nigeria.

It was observed from the hypothesis tested that carbon emission (CARBON) has negative and insignificant impact on sustainable development in Nigeria because [t-Statistic; 0.8360; P-value (0.4102) was greater than its significant value (0.05]. The finding of this study was in line with study of Iyabo, Lawal, Olayinka & Akinsola, (2021) [15] that explored impact of carbon emissions and economic gro21wth in Nigeria. This study tests the environmental kuznet curve (EKC) hypothesis to find evidence of an inverted-U relationship between carbon emissions and economic growth in Nigeria from 1980-2016. Annual time series data was gotten from world development index (WDI). The methods of data analysis were ADF Fisher Chi-square test, Pedroni's co-integration test, Toda Yamamoto Causality Test and Auto-regressive distributive Lag Model ARDL. There is an inverted U relationship or a turning point is reached when EKC hypothesis is accepted. The ekc is accepted if there is a positive relationship between GDP and CO2 on the short run and a negative relationship between CO2 and GDP on the long run. The findings show that Nigeria has not reached a turning point in its level of carbon emissions as economic growth increases. Nigeria is still at the initial stage of growth

where carbon emissions accelerate as growth increases.

Effect of green-house gas on sustainable development in Nigeria.

It was observed from the hypothesis tested that green-house emission (GRHG) has positive and significant impact on sustainable development in Nigeria because [t-Statistic; -0.8360; P-value (0.2303) was greater than its significant value (0.05]. The finding of this study was in line with study of Aigbedo and Aigbovo, (2020) [4] that examined the impact of climate change on growth in Nigeria. The specific objectives of the study were to ascertain the impact of temperature (TEMP); carbon emissions (CO2) and energy consumption (ENC) on real gross domestic product per capita (RGDPPC) using data for the period 1981-2021. Changes in temperature and carbon emission were used to capture climate change, while energy consumption was used as a control variable. The study employed the error Correction Model and ordinary least squares (OLS) estimation technique. The results indicate that in the long run, carbon emissions affect growth adversely. In addition, energy consumption impacts positively growth in the short run and long run. These results imply that the Nigerian government should evolve and implement policies to curb carbon emissions.

Summary of Findings

The following are the major findings of the study**:**

- Carbon emission has negative and insignificant impact on sustainable development in Nigeria because [t-Statistic; 0.8360; P-value (0.4102) was greater than its significant value (0.05]. The carbon emission has 17 percent negative and insignificant impact on sustainable development in Nigeria. A percent change in carbon emission results to 17 percent decrease in sustainable development in Nigeria.
- Green-house emission has positive and significant impact on sustainable development in Nigeria because [t-Statistic; -0.8360; P-value (0.2303) was greater than its significant value (0.05]. The green-house emission has 51 percent negative and insignificant impact on sustainable development in Nigeria. A percent change in green-house emission results to 51 percent decrease in sustainable development in Nigeria.

Conclusion

The study aimed at examining the effect of climate change on sustainable development in Nigeria from the periods 1990 to 2022. This study concludes that climate change has negative and insignificant impact on sustainable development in Nigeria. The study identify that green-house emission (GRHG), carbon emission (CARBON) and Deforestation (FOREST) have negative and insignificant impact on sustainable development in Nigeria. The study provided empirical evidence that fail to support the position of Environmental Kuznets Curve theory that environmental degradation determinants have positive influence with economic growth and later environmental degradation determinants decline as rising national income passes beyond a tipping point. The Environmental Kuznets Curve considers the relation between different indicators reflecting environmental pollution and per capita income. Although environmental pollution increases in the first stages of economic growth, when higher levels of income are reached, economic growth provides environmental improvement. So the Environmental Kuznets Curve hypothesis proposes a relation between GDP and environmental pollution that appears to be an inverted U shape (Stern, 2003). There is an inverted U relationship or a turning point is reached when EKC hypothesis is accepted. s

Recommendations of the study

Based on the findings of this study, the following recommendations were made.

- Government of Nigeria should implement policies that will encourage the use of carbon capture and storage (CCS) technology involves capturing carbon emission from non-renewable energy consumption and other carbon emission generated by human activities at its sources example; household gas emission or industrial facilities—and storing it permanently underground in geologic formations, such as depleted oil and gas reservoirs. Policymakers should focus on increasing the proportion of biomass energy consumption in total energy use to establish a sustainable future. Biomass energy consumption in terms of renewable energy rises environmental quality; hence, with increasing economic development.
- Government of Nigeria should raise public awareness to industrial sectors in order to reduce environmental pollution and make significant structural reforms. Likewise, people become more aware of environmental concern and follow environmental laws and regulations with a better income. This awareness and structural change diminish environmental degradation in turn because environmental contamination.

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